THE CLAIMS

What is claimed is:

1. A method of recycling a donor wafer after detachment of a useful layer of a semiconductor material therefrom, wherein the donor wafer, after detachment of the useful layer, includes a substrate, a buffer structure on the substrate and a remaining portion of the useful layer, which method comprises mechanically removing at least part of the remaining portion of the useful layer in order to provide a donor wafer surface that is suitable for use in a subsequent detachment of a useful layer.

2. The method of claim 1, wherein the mechanically removing comprises polishing, optionally accompanied by chemical etching.

3. The method of claim 2, wherein the polishing is abrasive polishing or chemical-mechanical planarization.

4. The method of claim 2, which further comprises conducting a surface smoothing treatment before polishing, after polishing, or both before and after polishing.

5. The method of claim 4, wherein the surface smoothing treatment includes a heat treatment.

6. The method of claim 1, wherein, before detachment, the buffer structure includes a buffer layer and an additional layer that has (a) a thickness which is sufficient to contain defects therein or (b) a surface lattice parameter which is substantially different from that of the substrate.

7. The method of claim 6, wherein the mechanically removing includes removing all of the remaining portion of the useful layer and part of the additional layer or all of the additional layer and part of the buffer layer.

8. The method of claim 1, which further comprises providing at least one new layer on the donor wafer after mechanically removing at least part of the remaining portion of the useful layer so as to form a new useful layer or new buffer structure above the existing buffer structure.

9. The method of claim 8, which further comprises, before detachment, providing the donor wafer with an overlayer which includes the useful layer to be detached, and wherein the mechanically removing removes any portion of the overlayer that remains after detachment.

10. The method of claim 9, wherein the overlayer includes

(a) a material selected from the group consisting of SiGe and strained Si;

(b) a material selected from the group consisting of AsGa and Ge; or

(c) InP or another alloy of Group III-V elements.

11. The method of claim 8, which further comprises providing at least two new layers on the donor wafer after mechanically removing at least part of the remaining portion of the useful layer so as to form an interlayer between the buffer structure and the new useful layer, with the interlayer optionally being provided by layer growth.

12. The method of claim 11, wherein the interlayer includes

(a) a material selected from the group consisting of SiGe and strained Si;

(b) a material selected from the group consisting of AsGa and/or Ge;

(c) an alloy of Group III-V elements; or

(d) a material selected from the group consisting of InP and a Group III-V material having a lattice parameter substantially identical to that of InP.

13. The method of claim 11, wherein the buffer structure has a composition that includes an atomic alloy of binary, ternary, quaternary or of higher degree, selected from the group consisting of Group IV-IV elements; Group III-V elements, and Group II-VI elements.

14. The method of claim 1, wherein

(a) the substrate includes Si and the buffer structure includes a SiGe buffer layer having a Ge concentration that increases with thickness and a relaxed SiGe layer on the buffer layer;

(b) the substrate includes AsGa and the buffer structure comprises a buffer layer comprising an atomic alloy of Group III-V elements of ternary or higher degree that is selected from possible (Al,Ga,In)-(N,P,As) combinations with at least two additional elements selected from the group consisting of Group III and Group V elements, wherein the two additional elements have a concentration that changes gradually with thickness of the buffer layer;

(c) the donor wafer has at least one layer that includes carbon with a carbon concentration in the layer which is less than or equal to about 50%; or

(d) the donor wafer has at least one layer that includes carbon with a carbon concentration in the layer which is less than or equal to about 5%.

15. The method of claim 1, which further comprises:

providing a zone of weakness beneath the donor wafer surface;

bonding the donor wafer surface to a surface of a receiving substrate; and

detaching a useful layer from the donor wafer along the zone of weakness

16. The method of claim 15, wherein the method further comprises, before the bonding step, forming a bonding layer on the donor wafer surface.

17. The method of claim 15, wherein the zone of weakness is formed by implantation of atomic species or by porosification.

18. The method of claim 1, wherein the useful layer that is detached includes part of the buffer structure.

19. The method of claim 1, wherein the donor wafer includes, before detachment, an overlayer located on the buffer structure, and the useful layer that is detached includes at least part of the overlayer.

20. A donor wafer produced according to the method of claim 1.

21. The donor wafer of claim 20, wherein all of the useful layer is removed so that only the substrate and the buffer structure is present.

22. The donor wafer of claim 21, wherein the buffer structure includes a buffer layer and an additional layer, with the additional layer having a thickness which is sufficient to contain defects or having a surface lattice parameter which is substantially different from that of the substrate, and a portion of the additional layer remains on the buffer structure.

23. The donor wafer of claim 21, wherein the buffer structure includes an overlayer and a portion of the overlayer remains on the buffer structure.

24. The donor wafer of claim 23, further comprising an interlayer between the substrate and the overlayer.

25. The donor wafer of claim 23, wherein the overlayer includes
(a) a material selected from the group consisting of SiGe and strained Si;
(b) a material selected from the group consisting of AsGa and Ge; or
(c) InP or another alloy of Group III-V elements.

26. The donor wafer of claim 24, wherein the interlayer includes
(a) a material selected from the group consisting of SiGe and strained Si;
(b) a material selected from the group consisting of AsGa and/or Ge;
(c) an alloy of Group III-V elements; or
(d) a material selected from the group consisting of InP and a Group III-V material having a lattice parameter substantially identical to that of InP.

25. The donor wafer of claim 20, wherein the buffer structure has a composition that includes an atomic alloy of binary, ternary, quaternary or of higher degree, selected from the group consisting of Group IV-IV elements; Group III-V elements, and Group II-VI elements.

26. The donor wafer of claim 20, wherein

(a) the substrate includes Si and the buffer structure includes a SiGe buffer layer having a Ge concentration that increases with thickness and a relaxed SiGe layer on the buffer layer;

(b) the substrate includes AsGa and the buffer structure comprises a buffer layer comprising an atomic alloy of Group III-V elements of ternary or higher degree that is selected from possible (Al,Ga,In)-(N,P,As) combinations with at least two additional elements selected from the group consisting of Group III and Group V elements, wherein the two additional elements have a concentration that changes gradually with thickness of the buffer layer;

(c) the donor wafer has at least one layer that includes carbon with a carbon concentration in the layer which is less than or equal to about 50%; or

(d) the donor wafer has at least one layer that includes carbon with a carbon concentration in the layer which is less than or equal to about 5%.